Introduction to PEEL™ Devices

Simple PLDs

Over the last few years a great deal of attention has been focused on higher pin count Complex PLDs (CPLDs). When first introduced, these newer and larger PLDs were predicted to totally replace Simple PLDs (SPLDs) such as PAL, GAL and PEEL™ Devices. While CPLDs have their merits, they have not eliminated the demand for SPLDs.

Why the continued popularity of SPLDs? As PACE Technologies PLD Market analyst, Ronnie Rohleder stated in her Electronic Buyers News column, "...**they're fast, cheap and ease-to-use... no sophisticated development system is required, and there's a wide range of architectures..."** The most flexible architectures among SPLDs are provided by PEEL™ Devices from ICT See Figure 1.

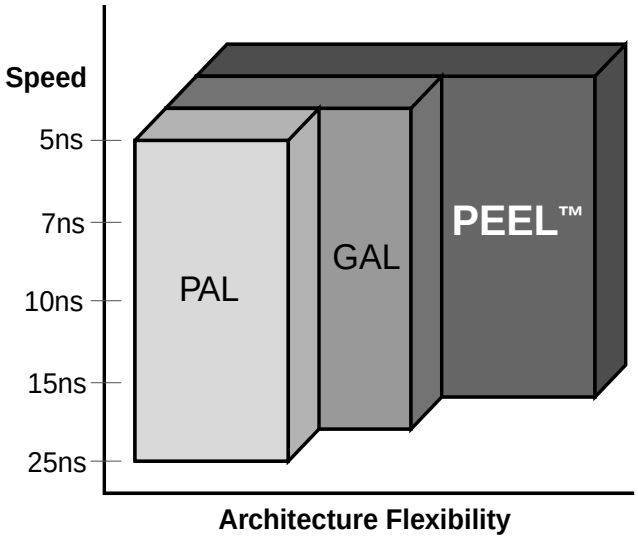

Figure 1 PEEL™ Devices offer flexible architectures at attractive speeds and prices.

PEEL™ Products from ICT

PEEL™ Devices are PAL, GAL and EPLD replacements, many of which offer enhanced architectures allowing more logic to be packed into every part. They're ideal for designers who have pushed ordinary PAL/GAL architectures to the limits and need more capability without the cost, complexity and learning curve associated with most CPLDs. PEEL™ Devices are offered in a wide range of speed and power options.

Development support for PEEL™ Devices is provided by ICT and popular third party development tool and programmer manufacturers, such as BP Microsystems. ICT offers the powerful and easy-to-use PLACE Development Software (free to qualified PLD Designers) complete with architectural editor, logic compiler and waveform simulator.

PEEL™ Device Types

There are two basic types of PEEL™ Device: direct replacements and superset replacements. See Table 1.

Direct replacement PEEL™ Devices include the PEEL™ 22CV10A, 22CV10AZ. These devices are JEDEC file and function compatible with industry-standard architectures. **Superset replacement** PEEL™ Devices include the PEEL™ 18CV8, 18CV8Z, 18LV8Z, 22CV10A+, 22CV10AZ+, and 22LV10AZ. These devices provide additional architecture features, beyond those of ordinary SPLDs, such as the 12-configuration macrocell.

Architectural Enhancements

Designing with PEEL™ Devices is much like designing with other 20 or 24-pin SPLDs. However, superset PEEL™ Devices give designers greater flexibility with additional inputs, product terms and macrocell configurations. An example of this is shown in Table 2, which compares a standard 16V8/22V10 architecture with an 18CV8/22CV10A enhanced architecture. The following information describes some of the design benefits of PEEL™ Devices enhanced architectures.

Independent Output Enables

Each I/O has independent programmable output enables for both combinatorial or registered outputs. The output enables are helpful for bus interfacing as well as "wire-O-Ring" of signals. Each I/O can be enabled or disabled via individual product terms, even on registered outputs where most standard PLDs offer only a single output enable control pin.

Global Preset and Clear

The PEEL™ 18CV8, and 22CV10AZ have a synchronous preset (SP) and an asynchronous clear (AC) product term that control all the registers. Although these functions are fairly straightforward, there are some unique ways to take advantage of them, especially for counters and state machines. An example is shown in the 8-bit Counter with Function Controls design in application note AN-1A in this data book.

Table 1 PEEL™ Device Selection Guide

	Architecture						Speed	Power		Packages	Key Features
	Pins	Inputs	I/Os	Registers	Macro Config	Product Terms	tPD (ns) (min)	ICC			
SPLD Superset Zero Power (5V)								Standby TYP/MAX	DYN (1 Mhz) TYP/MAX		
PEEL™ 18CV8Z	20	10	8	8	12	113	25	10 µA/ 100 µA	2 mA/ 5 mA	J, P, S, T	Pin-compatible superset of 20-pin PAL/ GAL/EPLD, Zero power
PEEL™ 22CV10AZ	24/28	12	10	10	4/12	133					Pin/JEDEC file compatible with standard 22V10s, Zero Power
SPLD Superset Zero Power (3V)								Standby TYP/MAX	DYN (1 Mhz) TYP/MAX		
PEEL™ 18LV8Z	20	10	8	8	12	113	25	5 µA/ 50 µA	1.5 mA/ 3 mA	J, P, S, T	Pin-compatible superset of 16V8/22V10, Zero Power 3V Schmitt Trigger
PEEL™ 22LV10AZ	24/28	12	10	10	12	133					
SPLD Superset Replacement								ICC (mA) (TYP)	ICC (mA) (Max)		
PEEL™ 18CV8	20	10	8	8	12	74	25, 15, 10, 7, 5	18-75	37-110	J, P, S, T	Pin-compatible superset of 20/24-pin PAL/ GAL/EPLD, lower power
PEEL™ 22CV10A	24/28	12	10	10	4/12	132	25, 15, 10, 7, 5	40-100	67-155		Pin/JEDEC file compatible with standard 22V10s

Twelve-Configuration Macrocell

All of ICT's superset SPLDs have a twelve-configuration macrocell as shown in Figure 2. Macrocell configuration numbers 3, 4, 9, and 10 (shaded in Figure 2) are the four macrocell configurations most similar to the standard SPLDs such as the 16V8 and 22V10. The additional eight macrocell configurations (1, 2, 5, 6, 7, 8, 11, and 12) can be used for a variety of logic functions not possible with ordinary SPLDs. These functions include:

l Bi-Directional Registered I/O

l Buried Combinational Feed back

l Buried Combinational Feedback with Register

l Buried Register with Combinatorial Output

The flexible output enable and register preset/clear controls can be used together with the extra macrocell configurations to implement a wide range of designs that will not fit into other devices. See AN-1A for design tricks and techniques that show details of how to use the enhanced PEEL™ Device architecture for real applications.

Table 2. SPLD Architecture Comparisons

Architecture Features	16V8/ 22V10	18CV8/ 22CV10A
Pin Count	20/24	20/24
Inputs (into Array)	16/20	18/22
Outputs	8	8
Feedbacks	6 or 8	8
Product Terms	64	74
Reg. Output Enables	shared pin	p-terms
Present/Clear P-terms	no	yes
Clock avail to Array	no	yes
Macro. Configurations	4	12
Buried Combinatorial	no	yes
Buried Registers	no	yes
Design Modes	3 modes: Simple, Complex, Registered	No modes needed, all macrocell configurations available
*Depends on Design Mode **Pseudo-Buried Register		

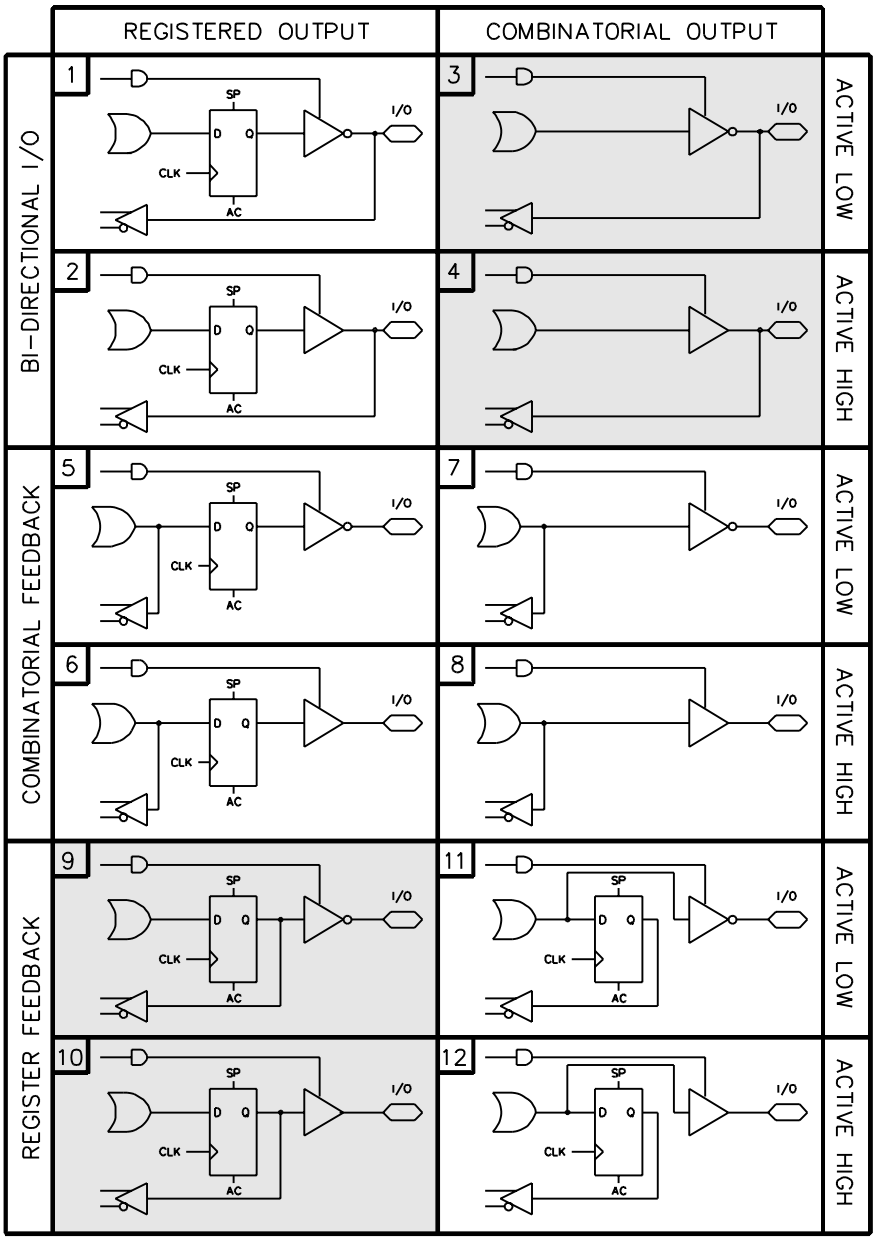

Figure 2. PEEL™ Device 12-Configuration Macrocell

Quick PEEL™ Device Cross Reference

Altera	ICT
EP220	PEEL18CV8
EP224	PEEL22CV10A
EP310	PEEL18CV8
EP320	PEEL18CV8
EP330	PEEL18CV8

AMI	ICT
PEEL18CV8	PEEL18CV8*
PEEL20CG10	PEEL22CV10A*
PEEL22CV10	PEEL22CV10A*

Atmel	ICT
ATF16V8	PEEL18CV8
ATF20V8	PEEL22CV8
	PEEL22CV10A
ATF22V10	PEEL22CV10A*

Cypress	ICT
PALC16R8	PEEL18CV8
PALC16R6	PEEL18CV8
PALC16R4	PEEL18CV8
PAL16R4	PEEL18CV8
PAL16L8	PEEL18CV8
PAL16R8	PEEL18CV8
PAL16R6	PEEL18CV8
PAL16R4	PEEL18CV8
PLDC18G8	PEEL18CV8
PLDC20G10	PEEL22CV10A
CG7C323B	PEEL22CV10A
PLDC20G10	PEEL22CV10A
PLD20G10	PEEL22CV10A
PALC22V10	PEEL22CV10A*
PAL22VP10	PEEL22CV10A*

Intel	ICT
5CO31	PEEL18CV8
5CO32	PEEL18CV8
85C22V10	PEEL22CV10A*
PLD22V10	PEEL22CV10A
85C220	PEEL18CV8
85C224	PEEL22CV8 PEEL22CV10A
Lattice	**ICT**
GAL16V8	PEEL18CV8
GAL20V8	PEEL22CV10A
GAL22V10	PEEL22CV10A*
GAL22LV10Z	PEEL22LV10AZ

National	ICT
GAL16V8	PEEL18CV8
GAL20V8	PEEL22CV10A
GAL22CV10	PEEL22CV10A*
GAL22V10	PEEL22CV10A*
PAL10H8	PEEL18CV8
PAL10L8	PEEL18CV8
PAL12H6	PEEL18CV8
PAL12L6	PEEL18CV8
PAL14H4	PEEL18CV8
PAL14L4	PEEL18CV8
PAL16L2	PEEL18CV8
PAL16L8	PEEL18CV8
PAL16R8	PEEL18CV8
PAL16R6	PEEL18CV8
PAL16R4	PEEL18CV8
PAL12L10	PEEL22CV10A
PAL14L8	PEEL22CV10
PAL16L6	PEEL22CV10
PAL18L4	PEEL22CV10
PAL20L2	PEEL22CV10
PAL20L8	PEEL22CV10
PAL20L10	PEEL22CV10A
PAL20P8	PEEL22CV10A
PAL20R8	PEEL22CV10A
PAL20R6	PEEL22CV10A
PAL20R4	PEEL22CV10A
PAL20RP8	PEEL22CV10A
PAL10RP6	PEEL22CV10A
PAL20RP4	PEEL22CV10A
Philips	**ICT**
PLUS16R8	PEEL18CV8
PLUS16R6	PEEL18CV8
PLUS16R4	PEEL18CV8
PLUS16L8	PEEL18CV8
P3C18V8	PEEL 18LV8Z
PLUS20R8	PEEL22CV10A
PLUS20R6	PEEL22CV10A
PLUS20R4	PEEL22CV10A
PLUS20L8	PEEL22CV10A
PLUS22V10	PEEL22CV10A*
PL22V10	PEEL22CV10A*

TI	ICT
EP330	PEEL18CV8
TIBPAL16R4	PEEL18CV8
TIBPAL16R6	PEEL18CV8
TIBPAL16R8	PEEL18CV8
TIBPAL16L8	PEEL18CV8
TIBPAL20L8	PEEL22CV10A
TIBPAL20R4	PEEL22CV10A
TIBPAL20R6	PEEL22CV10A
TIBPAL20R8	PEEL22CV10A
TIBPAL22V10	PEEL22CV10A*
TIBPAL22CV10	PEEL22CV10A*
TIBPAL22VP10	PEEL22CV10A*
TICPAL22V10	PEEL22CV10A*

Vantis (AMD)	ICT
AmPAL18P8	PEEL18CV8
AmPAL20L10	PEEL22CV10A
AmPAL22P10	PEEL22CV10A
AmPAL22V10	PEEL22CV10A*
PAL10H8	PEEL18CV8
PAL10L8	PEEL18CV8
PAL12H6	PEEL18CV8
PAL12L6	PEEL18CV8
PAL14H4	PEEL18CV8
PAL14L4	PEEL18CV8
PAL16H2	PEEL18CV8
PAL16HD8	PEEL18CV8
PAL16L2	PEEL18CV8
PAL16RP4	PEEL18CV8
PAL16RP6	PEEL18CV8
PAL16RP8	PEEL18CV8
PALC16L8	PEEL18CV8
PALC16R4	PEEL18CV8
PALC16R6	PEEL18CV8
PALC16R8	PEEL18CV8
PALC18U8	PEEL18CV8
PALCE16V8	PEEL18CV8
PALC16R8	PEEL18CV8
PALC18U8	PEEL18CV8
PAL16L8	PEEL18CV8
PAL16R4	PEEL18CV8
PAL16R6	PEEL18CV8
PAL16R8	PEEL18CV8
PAL20R4	PEEL22CV10A
PAL20R6	PEEL22CV10A
PAL20R8	PEEL22CV10A
PALCE20V8	PEEL22CV10A
PAL20L10	PEEL22CV10A
PAL22V10	PEEL22CV10A*
AMPAL22V10	PEEL22CV10A*
PALCE22V10	PEEL22CV10A*
PALCE22V10Z	PEEL22CV10A Z

* These ICT PEEL™ devices are plug-in replacements for the PLDs listed using the existing JEDEC programming file